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STORM SEWER DESIGN by the Modified Rational Method

Design Criteria for Storm

Pipe Sizes STANDARD Manhole Sizes STANDARD

FSR Rainfall Model - England and Wales

Return Period (years)	2	PIMP (%)	100
M5-60 (mm)	19.000	Add Flow / Climate Change (%)	0
Ratio R	0.257	Minimum Backdrop Height (m)	0.200
Maximum Rainfall (mm/hr)	50	Maximum Backdrop Height (m)	1.500
Maximum Time of Concentration (mins)	30	Min Design Depth for Optimisation (m)	1.200
Foul Sewage (l/s/ha)	0.000	Min Vel for Auto Design only (m/s)	1.00
Volumetric Runoff Coeff.	0.750	Min Slope for Optimisation (1:X)	500

Designed with Level Soffits

Network Design Table for Storm

« - Indicates pipe capacity < flow

PN	Length (m)	Fall (m)	Slope (1:X)	I.Area (ha)	T.E. (mins)	Base Flow (l/s)	k (mm)	HYD SECT	DIA (mm)	Section Type	Auto Design
1.000	4.539	0.050	90.8	0.152	5.00	0.0	0.600	o	225	Pipe/Conduit	
1.001	4.131	0.050	82.6	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.002	8.756	0.060	145.9	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.003	10.001	0.060	166.7	0.000	0.00	0.0	0.600	o	225	Pipe/Conduit	
1.004	5.573	0.060	92.9	0.010	0.00	0.0	0.600	o	150	Pipe/Conduit	

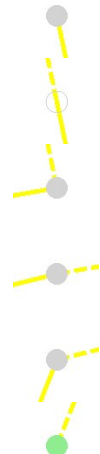
Network Results Table

PN	Rain (mm/hr)	T.C. (mins)	US/IL (m)	Σ I.Area (ha)	Σ Base Flow (l/s)	Foul (l/s)	Add Flow (l/s)	Vel (m/s)	Cap (l/s)	Flow (l/s)
1.000	50.00	5.06	160.100	0.152	0.0	0.0	0.0	1.37	54.6	20.6
1.001	50.00	5.10	159.950	0.152	0.0	0.0	0.0	1.44	57.2	20.6
1.002	50.00	5.24	159.900	0.152	0.0	0.0	0.0	1.08	42.9	20.6
1.003	50.00	5.40	159.840	0.152	0.0	0.0	0.0	1.01	40.2	20.6
1.004	50.00	5.49	159.780	0.162	0.0	0.0	0.0	1.04	18.4«	21.9

Manhole Schedules for Storm

MH Name	MH CL (m)	MH Depth (m)	MH Connection	MH Diam., L*W (mm)	PN	Pipe Out Invert Level (m)	Diameter (mm)	PN	Pipes In Invert Level (m)	Diameter (mm)	Backdrop (mm)
SW01	162.020	1.920	Open Manhole	1500	1.000	160.100	225				
Seperator	162.010	2.060	Junction		1.001	159.950	225	1.000	160.050	225	100
SW02	162.010	2.110	Open Manhole	1500	1.002	159.900	225	1.001	159.900	225	
Tank	162.000	2.160	Open Manhole	1200	1.003	159.840	225	1.002	159.840	225	
SW03	161.800	2.020	Open Manhole	1500	1.004	159.780	150	1.003	159.780	225	
	161.160	1.440	Open Manhole	1200		OUTFALL		1.004	159.720	150	

MH Name	Manhole Easting (m)	Manhole Northing (m)	Intersection Easting (m)	Intersection Northing (m)	Manhole Access	Layout (North)
SW01	389429.690	414176.881	389429.690	414176.881	Required	
Seperator	389430.621	414172.439			No Entry	
SW02	389431.466	414168.395	389431.466	414168.395	Required	
Tank	389422.843	414166.875	389422.843	414166.875	Required	
SW03	389413.133	414164.451	389413.133	414164.451	Required	
	389411.090	414159.266			No Entry	



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PIPELINE SCHEDULES for Storm

Upstream Manhole

PN	Hyd Sect	Diam (mm)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	o	225	SW01	162.020	160.100	1.695	Open Manhole	1500
1.001	o	225	Seperator	162.010	159.950	1.835	Junction	
1.002	o	225	SW02	162.010	159.900	1.885	Open Manhole	1500
1.003	o	225	Tank	162.000	159.840	1.935	Open Manhole	1200
1.004	o	150	SW03	161.800	159.780	1.870	Open Manhole	1500

Downstream Manhole

PN	Length (m)	Slope (1:X)	MH Name	C.Level (m)	I.Level (m)	D.Depth (m)	MH Connection	MH DIAM., L*W (mm)
1.000	4.539	90.8	Seperator	162.010	160.050	1.735	Junction	
1.001	4.131	82.6	SW02	162.010	159.900	1.885	Open Manhole	1500
1.002	8.756	145.9	Tank	162.000	159.840	1.935	Open Manhole	1200
1.003	10.001	166.7	SW03	161.800	159.780	1.795	Open Manhole	1500
1.004	5.573	92.9		161.160	159.720	1.290	Open Manhole	1200

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Network Classifications for Storm

PN	USMH Name	Pipe Dia (mm)	Min Cover Depth (m)	Max Cover Depth (m)	Pipe Type	MH Dia (mm)	MH Width (mm)	MH Ring Depth (m)	MH Type
1.000	SW01	225	1.695	1.735	Unclassified	1500	0	1.695	Unclassified
1.001	Seperator	225	1.835	1.885	Unclassified				Junction
1.002	SW02	225	1.885	1.935	Unclassified	1500	0	1.885	Unclassified
1.003	Tank	225	1.795	1.935	Unclassified	1200	0	1.935	Unclassified
1.004	SW03	150	1.290	1.870	Unclassified	1500	0	1.870	Unclassified

Free Flowing Outfall Details for Storm

Outfall Pipe Number	Outfall Name	C. Level (m)	I. Level (m)	Min I. Level (m)	D,L (mm)	W (mm)
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1.004		161.160	159.720	159.700	1200	0
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Simulation Criteria for Storm

Volumetric Runoff Coeff	0.750	Additional Flow - % of Total Flow	0.000
Areal Reduction Factor	1.000	MADD Factor * 10m ³ /ha Storage	2.000
Hot Start (mins)	0	Inlet Coefficient	0.800
Hot Start Level (mm)	0	Flow per Person per Day (l/per/day)	0.000
Manhole Headloss Coeff (Global)	0.500	Run Time (mins)	60
Foul Sewage per hectare (l/s)	0.000	Output Interval (mins)	1
Number of Input Hydrographs	0	Number of Offline Controls	0
Number of Online Controls	1	Number of Storage Structures	1
		Number of Time/Area Diagrams	0
		Number of Real Time Controls	0

Synthetic Rainfall Details

Rainfall Model	FSR	Profile Type	Summer
Return Period (years)	2	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	19.000	Storm Duration (mins)	30
Ratio R	0.257		

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Online Controls for Storm

Hydro-Brake® Optimum Manhole: SW03, DS/PN: 1.004, Volume (m³): 3.9

Unit Reference	MD-SHE-0100-5000-1400-5000
Design Head (m)	1.400
Design Flow (l/s)	5.0
Flush-Flo™	Calculated
Objective	Minimise upstream storage
Application	Surface
Sump Available	Yes
Diameter (mm)	100
Invert Level (m)	159.780
Minimum Outlet Pipe Diameter (mm)	150
Suggested Manhole Diameter (mm)	1200

Control Points	Head (m)	Flow (l/s)	Control Points	Head (m)	Flow (l/s)
Design Point (Calculated)	1.400	5.0	Kick-Flo®	0.855	4.0
Flush-Flo™	0.416	5.0	Mean Flow over Head Range	-	4.4

The hydrological calculations have been based on the Head/Discharge relationship for the Hydro-Brake® Optimum as specified. Should another type of control device other than a Hydro-Brake Optimum® be utilised then these storage routing calculations will be invalidated

Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)	Depth (m)	Flow (l/s)
0.100	3.3	0.800	4.3	2.000	5.9	4.000	8.2	7.000	10.7
0.200	4.6	1.000	4.3	2.200	6.2	4.500	8.6	7.500	11.0
0.300	4.9	1.200	4.7	2.400	6.4	5.000	9.1	8.000	11.4
0.400	5.0	1.400	5.0	2.600	6.7	5.500	9.5	8.500	11.7
0.500	5.0	1.600	5.3	3.000	7.1	6.000	9.9	9.000	12.0
0.600	4.9	1.800	5.6	3.500	7.7	6.500	10.3	9.500	12.3

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Storage Structures for Storm

Cellular Storage Manhole: Tank, DS/PN: 1.003

Invert Level (m) 159.840 Safety Factor 2.0
 Infiltration Coefficient Base (m/hr) 0.00000 Porosity 0.95
 Infiltration Coefficient Side (m/hr) 0.00000

Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)	Depth (m)	Area (m²)	Inf. Area (m²)
0.000	48.0	0.0	1.200	48.0	0.0	1.201	0.0	0.0

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1 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
 Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
 Hot Start Level (mm) 0 Inlet Coefficient 0.800
 Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
 Foul Sewage per hectare (l/s) 0.000

 Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
 Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.000 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.257 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
 Analysis Timestep 2.5 Second Increment (Extended)
 DTS Status ON
 DVD Status ON
 Inertia Status ON

Profile(s) Summer and Winter
 Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
 Return Period(s) (years) 1, 2, 30, 100
 Climate Change (%) 0, 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surcharge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water	Surcharged
									Level (m)	Depth (m)
1.000	SW01	15 Winter	1	+0%	30/15 Summer				160.220	-0.105
1.001	Seperator	15 Winter	1	+0%	30/15 Summer				160.070	-0.105
1.002	SW02	15 Winter	1	+0%	30/15 Summer				160.013	-0.112
1.003	Tank	60 Winter	1	+0%	30/15 Summer				159.989	-0.076
1.004	SW03	60 Winter	1	+0%	1/15 Summer				159.984	0.054

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Pipe Flow (l/s)	Status	Level Exceeded
1.000	SW01	0.000	0.54	17.2	OK	
1.001	Seperator	0.000	0.55	17.2	OK*	
1.002	SW02	0.000	0.50	17.4	OK	
1.003	Tank	0.000	0.13	4.3	OK	
1.004	SW03	0.000	0.30	4.6	SURCHARGED	

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2 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
 Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
 Hot Start Level (mm) 0 Inlet Coefficient 0.800
 Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
 Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
 Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.000 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.257 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
 Analysis Timestep 2.5 Second Increment (Extended)
 DTS Status ON
 DVD Status ON
 Inertia Status ON

Profile(s) Summer and Winter
 Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
 Return Period(s) (years) 1, 2, 30, 100
 Climate Change (%) 0, 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surge	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level	Surcharged Depth
									(m)	(m)
1.000	SW01	15 Winter	2	+0%	30/15 Summer				160.242	-0.083
1.001	Seperator	15 Winter	2	+0%	30/15 Summer				160.092	-0.083
1.002	SW02	60 Winter	2	+0%	30/15 Summer				160.052	-0.073
1.003	Tank	60 Winter	2	+0%	30/15 Summer				160.046	-0.019
1.004	SW03	60 Winter	2	+0%	1/15 Summer				160.041	0.111

PN	US/MH Name	Flooded Volume (m³)	Flow / Overflow Cap. (l/s)	Pipe Flow (l/s)	Status	Level
						Exceeded
1.000	SW01	0.000	0.70	22.2	OK	
1.001	Seperator	0.000	0.71	22.3	OK*	
1.002	SW02	0.000	0.39	13.3	OK	
1.003	Tank	0.000	0.14	4.5	OK	
1.004	SW03	0.000	0.32	4.8	SURCHARGED	

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30 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
 Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
 Hot Start Level (mm) 0 Inlet Coefficient 0.800
 Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
 Foul Sewage per hectare (l/s) 0.000

Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
 Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.000 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.257 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
 Analysis Timestep 2.5 Second Increment (Extended)
 DTS Status ON
 DVD Status ON
 Inertia Status ON

Profile(s) Summer and Winter
 Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
 Return Period(s) (years) 1, 2, 30, 100
 Climate Change (%) 0, 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surchage	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
1.000	SW01	60 Winter	30	+0%	30/15 Summer				160.367	0.042
1.001	Seperator	60 Winter	30	+0%	30/15 Summer				160.275	0.100
1.002	SW02	120 Winter	30	+0%	30/15 Summer				160.350	0.225
1.003	Tank	120 Winter	30	+0%	30/15 Summer				160.345	0.280
1.004	SW03	120 Winter	30	+0%	1/15 Summer				160.338	0.408

PN	US/MH Name	Flooded Volume (m³)	Flow / Overflow Cap. (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	SW01	0.000	0.80	25.2	SURCHARGED	
1.001	Seperator	0.000	0.77	24.1	SURCHARGED*	
1.002	SW02	0.000	0.48	16.6	SURCHARGED	
1.003	Tank	0.000	0.16	5.5	SURCHARGED	
1.004	SW03	0.000	0.33	5.0	SURCHARGED	

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100 year Return Period Summary of Critical Results by Maximum Level (Rank 1) for Storm

Simulation Criteria

Areal Reduction Factor 1.000 Additional Flow - % of Total Flow 0.000
 Hot Start (mins) 0 MADD Factor * 10m³/ha Storage 2.000
 Hot Start Level (mm) 0 Inlet Coefficient 0.800
 Manhole Headloss Coeff (Global) 0.500 Flow per Person per Day (l/per/day) 0.000
 Foul Sewage per hectare (l/s) 0.000

 Number of Input Hydrographs 0 Number of Offline Controls 0 Number of Time/Area Diagrams 0
 Number of Online Controls 1 Number of Storage Structures 1 Number of Real Time Controls 0

Synthetic Rainfall Details

Rainfall Model FSR M5-60 (mm) 19.000 Cv (Summer) 0.750
 Region England and Wales Ratio R 0.257 Cv (Winter) 0.840

Margin for Flood Risk Warning (mm) 300.0
 Analysis Timestep 2.5 Second Increment (Extended)
 DTS Status ON
 DVD Status ON
 Inertia Status ON

Profile(s) Summer and Winter
 Duration(s) (mins) 15, 30, 60, 120, 240, 360, 480, 960, 1440
 Return Period(s) (years) 1, 2, 30, 100
 Climate Change (%) 0, 0, 0, 40

PN	US/MH Name	Storm	Return Period	Climate Change	First (X) Surchage	First (Y) Flood	First (Z) Overflow	Overflow Act.	Water Level (m)	Surcharged Depth (m)
1.000	SW01	120 Winter	100	+40%	30/15 Summer				161.124	0.799
1.001	Seperator	60 Winter	100	+40%	30/15 Summer				160.275	0.100
1.002	SW02	120 Winter	100	+40%	30/15 Summer				161.119	0.994
1.003	Tank	120 Winter	100	+40%	30/15 Summer				161.113	1.048
1.004	SW03	120 Winter	100	+40%	1/15 Summer				161.107	1.177

PN	US/MH Name	Flooded Volume (m³)	Flow / Cap.	Overflow (l/s)	Pipe Flow (l/s)	Status	Level Exceeded
1.000	SW01	0.000	0.93		29.3	SURCHARGED	
1.001	Seperator	0.000	1.36		42.7	SURCHARGED*	
1.002	SW02	0.000	0.81		27.9	SURCHARGED	
1.003	Tank	0.000	0.14		4.7	SURCHARGED	
1.004	SW03	0.000	0.33		5.0	SURCHARGED	